Resilient Relay-Assisted mmWave Communication for Mobile Robots with ML-Based RSSI Prediction

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Mission

Provide high-quality wireless communication for robot control by **optimizing the use of communication resources** and **detecting the radio environment**, even in severe radio environments.

ABSTRACTS

- **Challenge:** mmWave links in mobile robotic systems are highly vulnerable to blockage and NLoS conditions.
- **Objective:** Demonstrate a resilient mmWave communication setup under severe blockage.
- **Approach:** Implement a **relay-assisted mmWave network** between a base station and a remote device when the direct path is blocked.
- **Relay Design:** Use an **amplify-and-forward (AF) relay** with independent transmit and receive beamformers to mitigate self-interference.
- **Outcome:** The relay restores connectivity and improves link robustness in blocked mmWave scenarios without requiring instantaneous CSI.

SYSTEM MODEL

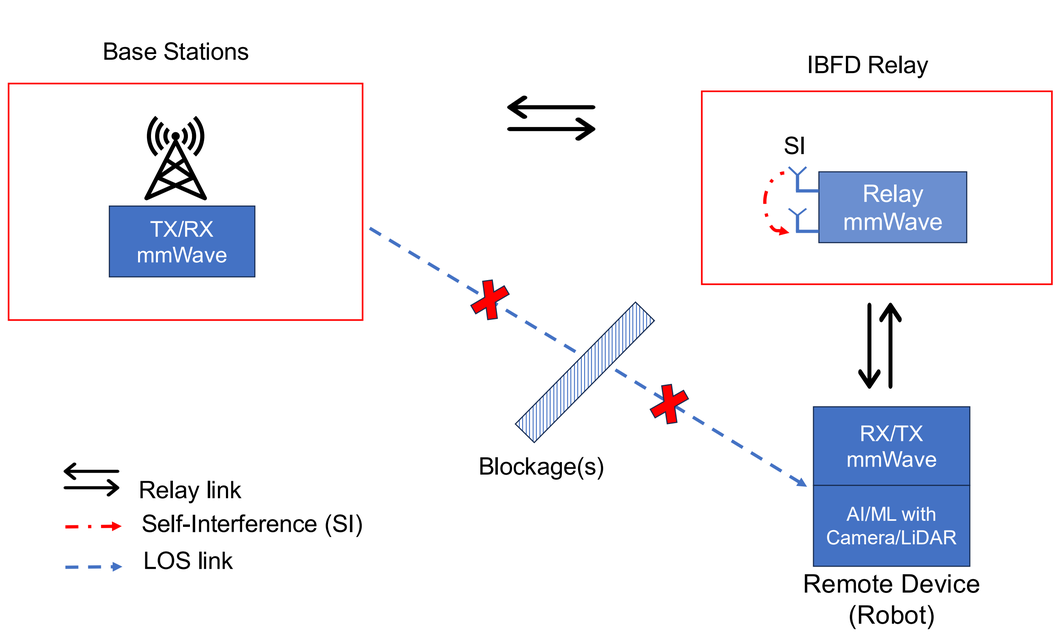


Fig.1: Proposed robot communication system with mmWave links for robust connectivity in dynamic, obstructed environments.

EXPERIMENTAL SETUP

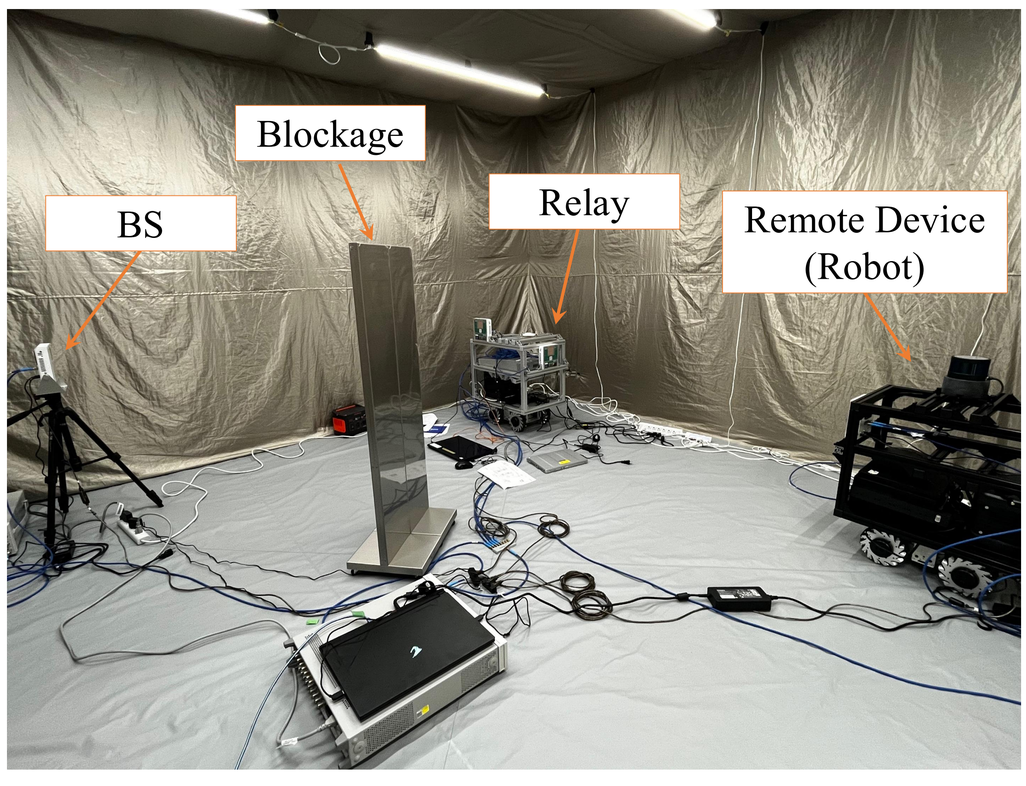
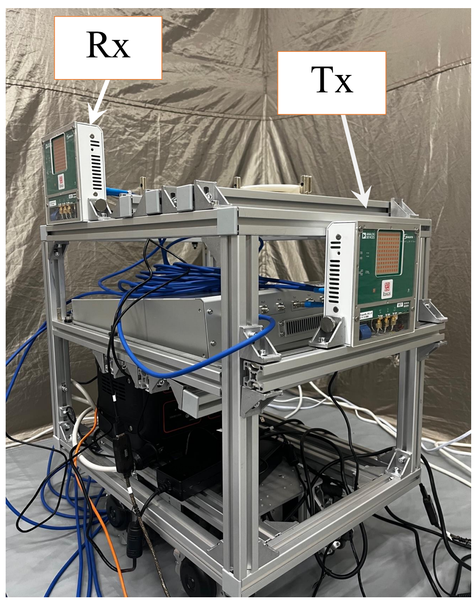


Fig.2: Experimental demo setup for 28GHz mmWave relay-assisted communication system

(a) Base station (BS)

(b) Remote Device (Robot)

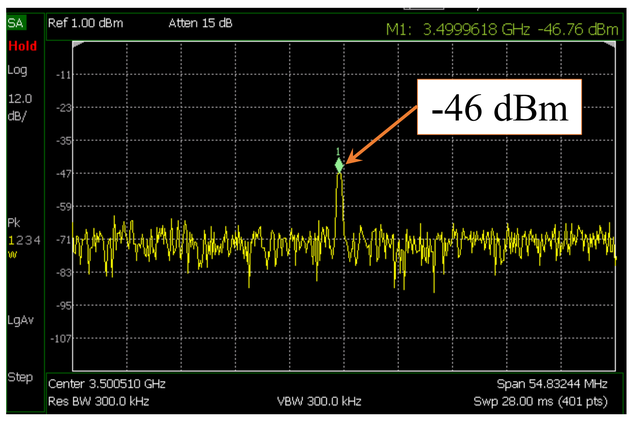


(c) Relay station

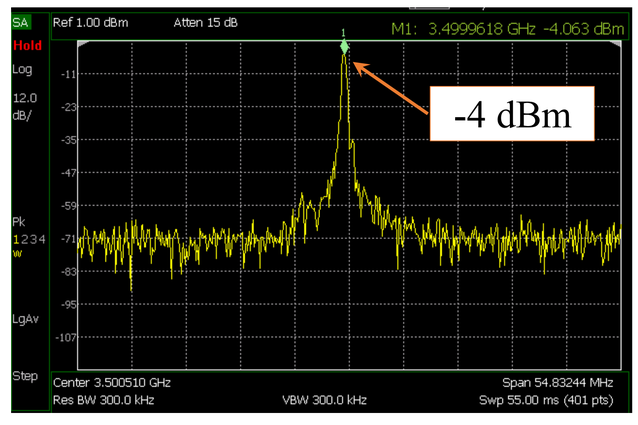
(d) 28GHz mmWave 8×8 phased array antenna module (Dragonfly)

Fig. 3: Base station, relay station, and mobile robot used in the experimental setup

EVALUATION



(a) Without Relay (BS => Robot)



(b) With Relay (Relay => Robot)

Fig. 4: Received signal power spectrum at the remote device (Robot)

Conclusion

- Relay-assisted mmWave communication restores links under blockage.
- AF relay with independent beamforming improves NLoS robustness without CSI.
- **Future work:** integrate RSSI prediction for proactive link adaptation and further enhance resilience in dynamic environments.

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